Mega-Sweep

Sweeping Oscillator (Issue F)

KAY ELECTRIC COMPANY

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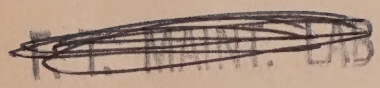
OPERATING AND MAINTENANCE

MANUAL

ISSUE F

Mega-Sweep

SWEEPING OSCILLATOR



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INSTRUCTION MANUAL
THE MEGA-SWEEP
Table of Contents

		Page
Section I	Introduction	1
1.1	Description	1
1.2	Specification	1
1.3	Purpose	2
1.4	General Circuit Description	2
Section II	Operating Instructions	3
2.1	Preliminary	3
2.2	Power Input	3
2.3	Controls	3
2.4	Connectors	5
2.5	Initial Adjustment	5
2.6	Summary of Operation Procedure	7
2.7	Adjustment for 1000 Megacycle Operation	7
Section III	General Theory	8
3.1	General Design Features	8
3.2	Beat Frequency Oscillators	8
3.3	Wave Guide	9
3.4	Wave Meter	9
3.5	Output System	10
3.6	Sweep Circuit	10
Section IV	Interconnections to Other Equipment	11
4.1	Connection to Oscilloscope	11
4.2	RF Connections to Test Circuits	11
4.3	Marker Connections	11
4.4	Connections to TV Receivers	12
4.5	Pulse Modulation of the MEGA-SWEEP with the MEGA-PULSER	13
4.6	Use of External Sweep Voltages	14
Section V	Service and Maintenance Notes	15
5.1	Low Output Signal	15
5.2	Voltage Measurement	15
5.3	Crystal Removal	16
5.4	Crystal Testing	16
5.5	CRYSTAL PROTECTION - NOTE IN DETAIL	16
5.6	Klystron Replacement	16
5.7	Fuse Replacement	17
Section VI	Methods of Setting Frequency	18
6.1	By Use of Test Circuit	18
6.2	By Use of Wavemeter with Oscilloscope Display	18
Appendix A	The Calibrated MEGA-SWEEP	22

THE STANDARD MEGA-SWEEP, 100-A

THE CALIBRATED MEGA-SWEEP, 110-A

SECTION I

INTRODUCTION

1.1 Description

The MEGA-SWEEP is a wide range sweeping oscillator which provides a frequency sweep of thirty or more megacycles over a range of 50 kilocycles to 1000 megacycles.

1.2 Specification

1. Frequency range: 50 kc. to 800 mc.; adjustment necessary to extend the range to 1000 mc.

2. Frequency sweep: 30 mc. minimum (at maximum of SWEEP AMPLITUDE).

3. Sweep rate: 50 to 100 cps. Synchronizing voltage is introduced in order that the sweep rate may be locked in at 60 cps. External sweeps may be used.

4. Sweep voltage output: approximately 20 volts. This sawtooth voltage is available at the SWEEP OUTPUT and should be used for the oscilloscope sweep.

5. RF output impedance: approximately 50 ohms on both HIGH and LOW.

6. Output voltage: approximately 100 millivolts into open circuit for HIGH; approximately 5 millivolts into open circuit for LOW.

7. RF output control: uncalibrated microwave attenuator continuously variable over a 26 db range; attenuation characteristic flat over frequency range.

8. Frequency measurement: accuracies of $\pm 1\% + 5$ mc may be obtained by use of the micrometer controlled wavemeter.

9. Harmonic distortion: less than 5% at maximum output; less than 2% at 50% maximum output.

10. Amplitude modulation: less than 0.1 db per megacycle.

11. Leakage: no measurable amount of beat frequency energy.

12. Power: 105 to 125 volts; 50 to 60 cps, approximately 110 watts.

13. Dimensions: 10" x 12" x 17".

14. Weight: 45 lbs.

1.3 Purpose

The MEGA-SWEEP supplies a frequency modulated or swept signal with adjustable center frequency. The output signal is virtually constant in amplitude while sweeping. In conjunction with an oscilloscope the amplitude response vs. frequency of broad band circuits may be continuously displayed. Such a display facilitates circuit adjustment and alignment.

1.4 General Circuit Description

The MEGA-SWEEP is a beat frequency oscillator employing two X-band (8500-9700 mc.) klystrons, a waveguide assembly, and a silicon crystal detector. A meter indicates the DC component of the crystal current. A sawtooth voltage is generated by a thyratron relaxation oscillator and is applied to the repeller of one of the klystrons. The output signal voltage is controllable by means of an adjustable carbon attenuator card in one of the waveguides. An absorption type wavemeter is coupled into one of the waveguides for use in measuring the frequency of the output signal. The above circuits are mounted on the front panel.

The power supply provides regulated voltages for the klystrons and sweep tube. The power supply is mounted on a chassis to the rear of the MEGA-SWEEP and voltages for the panel are connected through a cable. This cable is of sufficient length in order that the front panel may easily be removed.

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SECTION II

OPERATING INSTRUCTIONS

2.1 Preliminary

The space inside the top cover of the instrument is packed with tissue paper to protect the tubes during shipment. This packing should be removed before operating the unit.

2.2 Power Input

The instrument should be connected to the 117 volt, 50 to 60 cps. line. The power consumption is approximately 110 watts.

2.3 Controls

A. General

Reference should be made to the instrument front panel or to Fig. 5. Switch ON-OFF is a toggle switch which controls the 117 volt AC power. A pilot light indicates the presence of AC power. A 3 amp. fuse is replaceable from the front panel.

B. Beat frequency oscillator controls:

1) PEAKING ADJ. #1

PEAKING ADJ. #1 controls the negative voltage on the repeller electrode of the variable frequency klystron, V1. This control is used in adjusting V1 for maximum output as indicated by meter M1.

2) Peaking switch

PUSH switch (S1 in Fig. 2) is a momentary contact toggle switch. In its normal position both klystrons are in operation. Since the output of V1 is much greater than V2, meter M1 indicates essentially the DC component from V1. With the switch depressed klystron V1 is disabled and the sensitivity of meter M1 is increased. Thus with the switch depressed the meter indicates the DC component from klystron V2. This switch allows the operator to maximize the output of each klystron.

3) PEAKING ADJ. #2

PEAKING ADJ. #2 controls the negative voltage on the repeller electrode of the fixed frequency klystron, V2. It is used to maximize the output of V2 as indicated by meter M1 with the PUSH switch depressed.

C. Frequency adjustment and determination:

1) COARSE FREQUENCY ADJ.

The COARSE FREQUENCY ADJ. is a mechanical connection to the cavity of the variable frequency klystron, V1. Rotation of this control changes the dimensions of the klystron cavity, thus changing the output frequency. The output frequency is determined by the difference in frequencies of the two klystrons V1 and V2. The variable klystron V1 normally works below V2 in frequency. Under this condition, clockwise rotation of COARSE FREQUENCY ADJ. raises the output frequency. When the COARSE FREQUENCY ADJ. is rotated more than one turn it may be necessary to readjust PEAKING ADJ. #1 for maximum output on M1.

2) FREQUENCY METER

The FREQUENCY METER is a tunable cavity absorption type wavemeter. The resonant frequency of the cavity is adjusted by rotating the micrometer head. By tuning the cavity for a dip in the reading on M1 with the peaking switch, S1, depressed a reading is obtained that is proportional to the frequency of the fixed frequency klystron V2. By releasing S1 and retuning the FREQUENCY METER for a dip in the indication of M1 (for a sharp dip the SWEEP AMPLITUDE should be turned full counterclockwise) a second reading is obtained proportional to the frequency of the variable klystron V1. The difference in these readings multiplied by the FREQUENCY METER factor is the frequency output in megacycles. (See tables I and II for discussion of proper FREQUENCY METER factor.)

3) Fine tuning control

The FINE FREQUENCY ADJ. varies the repeller voltage on klystron V2 by a small amount. Since the frequency of V2 is proportional to repeller voltage (Fig. 3) small changes in output frequency result. This control is used for small frequency variation when narrow bands are being swept. It acts as a vernier for the COARSE FREQ. ADJ.

D. Sweeping voltage controls:

1) SWEEP WIDTH control

The SWEEP WIDTH control adjusts the amplitude of the sawtooth voltage from the relaxation oscillator (V3, Fig. 2) applied to the repeller electrode of V1. The sweep width in megacycles of the output signal is proportional to this amplitude. SWEEP WIDTH is marked in megacycles.

The calibration is approximate. The sweep width of the klystron vs. sweep voltage amplitude varies from klystron to klystron and also varies with the modes of the klystron. Thus the position of PEAKING ADJ. #1 should be set for the mode which permits obtaining the sweep width desired.

2) SWEEP RATE

The SWEEP RATE varies the sweep frequency of the relaxation oscillator over the range of approximately 50 to 100 cps. A small amount of the AC filament voltage is fed into the grid in order that the sweep rate may be synchronized with the power line frequency.

E. Output level:

1) Attenuator

The ATTENUATION control is included for varying the output level of the unit. Attenuation of the output signal is increased when this control is rotated clockwise. It should be noted that several rotations of this control are required between minimum and maximum. To insure that the attenuation is a minimum the control should be rotated counterclockwise until the shaft becomes loose.

2.4 Connectors

A. Output:

1) HIGH

A BNC type connector is provided.

2) LOW

A second BNC connector provides an output of 26 db less signal than from the HIGH.

2.5 Initial Adjustment

A. Oscillator peaking:

As explained above, this equipment is a beat frequency device, and each klystron will oscillate in different modes

(at various values of repeller voltage). The center frequency of these modes is nearly the same but it is still necessary to establish maximum output from each klystron. To accomplish this the following steps are necessary:

1) Turn ATTENUATION control counterclockwise. (about 13 turns)

2) Rotate micrometer until the thimble uncovers the number 20.

3) Depress PUSH switch and rotate PEAKING ADJ. #2 for maximum output on M1. (There are usually three peaks, the largest of which should be selected.)

4) Release the PUSH switch.

5) Adjust PEAKING ADJ. #1 for maximum output on one of the klystron modes. There are usually three modes, the largest of which should be selected. For maximum sweep width the smallest peak may be selected. This adjustment should be made with the SWEEP AMPLITUDE in its counterclockwise position.

Note that these adjustments are made with no connections to the HIGH output connector. If a DC short (such as a coil) is across the HIGH output connector, the meter M1 is shorted out and no reading is observed.

B. Frequency Determination:

The adjustments in the preceding section assure that both klystrons are oscillating. To measure the frequency after the COARSE FREQUENCY ADJ. has been set, two readings should be obtained from the wavemeter.

1) Depress the PUSH switch and rotate the FREQUENCY METER until a dip is obtained on the meter M1.

2) Release switch; set SWEEP AMPLITUDE counterclockwise.

3) Rotate FREQUENCY METER until the second dip is obtained. The difference between these two multiplied by the proper factor gives the output frequency.

4) After having obtained the correct frequency, rotate the FREQUENCY METER until 20 shows on the micrometer. This final adjustment is made in order that the FREQUENCY METER will not distort the pass band that is being measured.

2.6 Summary of the Operation Procedure:

1) Set SWEEP AMPLITUDE control counterclockwise(i.e., zero sweep).
2

2) Set ATTENUATOR control counterclockwise (i.e., minimum attenuation).

3) Hold down the PUSH switch associated with PEAKING ADJ. #2, and maximize the current by rotation of PEAKING ADJ. #2. Rotate the FREQUENCY METER until a dip is obtained.

4) Record this reading; release switch.

5) Set FREQUENCY METER at a position corresponding to the desired frequency of the local oscillator. (See Tables I and II).

6) Rotate PEAKING ADJ. #1 for maximum current.

7) Adjust COARSE FREQUENCY ADJ. knob until the meter indicates a dip.

8) Back off FREQUENCY METER (counterclockwise) to a point beyond that at which the #2 oscillator dip was encountered. Set SWEEP WIDTH control to desired sweep width. The instrument is now ready for operation.

Caution: Do not apply voltage to the sweeping oscillator output jack. It is possible to damage the sensitive meter and the silicon crystal by such application. Crystal burnout may be prevented if only the higher frequencies (above 15 megacycles) are needed. This is accomplished by placing a small series condenser (about 100 micro-micro-farads) in series with the output cable.

2.7 Adjustment for 1000 Megacycle Operation:

The MEGA-SWEEP is capable of signal outputs up to 1000 megacycles. To obtain a range up to 1000 megacycles, remove the klystron shield box top at the right rear of the panel. Adjust the cavity nut on #2 klystron (tube to the right). Since the shell of this tube is at + 300 volts, an insulated wrench must be used or the power turned off before adjustment is made. With the PUSH switch depressed and ATTENUATION turned completely counterclockwise and PEAKING ADJ. #2 adjusted for maximum, the cavity nut should be rotated for a dip on the meter with FREQUENCY METER adjusted between 1980 and 2000. Setting the variable klystron (#1) for a dip with the FREQUENCY METER below zero then allows frequencies around 1000 mc. to be obtained.

SECTION III

GENERAL THEORY

3.1 General Design Features

The MEGA-SWEEP employs two X-band klystrons as signal sources. The outputs of these two sources are conducted by a wave guide assembly to a silicon crystal detector which detects the difference frequency between them. This difference frequency signal appears across two output coaxial connectors. One of the klystrons, #2, is fixed in frequency during operation. The other klystron, #1, is frequency modulated or swept by application of a sawtooth voltage to the repeller. In addition the center frequency of the #1 klystron can be varied by a shaft connection from the front panel COARSE FREQUENCY ADJ. knob which varies the cavity dimensions of the tube. To facilitate beat frequency oscillator adjustment, a meter reads the DC component of the detector crystal current.

The positive and negative DC potentials required by all tubes are supplied from an electronically regulated power supply. To minimize frequency drift in the klystrons, these voltages are closely regulated and low ripple maintained.

The wave guide assembly includes a carbon card attenuator, adjustable from the front panel, which controls the output signal amplitude by attenuating the signal transmitted to the crystal detector from the fixed frequency, #2, klystron. An absorption type wavemeter is coupled into the waveguide for use in measuring the center frequency of the output signal or some frequency along the sweep.

The sawtooth sweeping voltage is generated by a thyratron tube in a relaxation oscillator circuit. The repetition rate and amplitude of the sawtooth voltage are adjusted by front panel controls. A fixed amount of this sawtooth voltage is made available at front panel posts for use in sweeping an oscilloscope in the horizontal direction.

Fig. 1 is a block diagram of the MEGA-SWEEP showing its more important elements. The fixed frequency klystron A is mounted so that its output probe inserts into wave guide L. The energy from this tube is attenuated by the variable attenuator J. Energy from the variable frequency klystron B is coupled into wave guide H. Wave guides L and H are coupled together by means of directional coupler K. The wavemeter G is coupled into wave guide H and the frequency difference between the two oscillators is detected by silicon crystal F. Sawtooth sweep voltage from relaxation sweep generator D is connected to the variable frequency klystron B and to the sweep voltage output post. The regulated power supply E supplies current for oscillators A, B and D. The microammeter M reads the DC current component in the crystal output. A circuit C is provided for disabling the variable frequency klystron B so that the activity of each klystron (A and B) can be indicated separately on the microammeter M.

3.2 Beat Frequency Oscillators

The two beat frequency oscillators A and B in Fig. 1 are indicated schematically as V2 and V1 on the Panel Schematic Fig. 2. These oscillators are 723 A/B

type reflex klystrons. The negative 300 volt section of the power supply is used to deliver potential to the repellers of V1 and V2 through resistors and potentiometers R1, R2, R3, R4, R5, R6, R7, R8, and R9. The repeller voltage of V1 can be adjusted by potentiometer R8; and the repeller voltage of V2 by potentiometer R2. These adjustments are required since the frequency and amplitude of oscillation are determined by the repeller voltage at any given cavity setting. This characteristic is illustrated in Fig. 3 where frequency and amplitude of oscillation are plotted vs. repeller voltage for a typical klystron. It will be understood that the center frequency of each frequency vs. repeller voltage curve is varied by changing dimensions of the cavity. In addition the repeller voltage required for maximum oscillator amplitude varies with cavity setting.

3.3 Wave Guide

The outputs from the two oscillators A and B of Fig. 1 are coupled into the two wave guide sections L and H through probes. Section L contains the carbon card variable attenuator J and a carbon card matching device N. This latter card terminates section L so that a minimum of energy is reflected. Energy from section L is coupled through directional coupler K into wave guide section H. Energy from oscillator B is coupled through a probe into wave guide section H. This section contains a buffer resistance card I which isolates oscillator B from the output load. Wave guide section H is terminated by crystal mixer assembly F. Wavemeter G is also coupled into section H.

The directional coupler K attenuates the energy from section L reaching section H so that the mixer F receives much less energy from oscillator A than from oscillator B. Since B is swept in frequency its amplitude varies (See Fig. 3). The amplitude from A does not vary since the frequency is fixed. In any heterodyne process, if one signal is much smaller than the other, it controls the amplitude of the difference frequency output. Consequently, because of the attenuation resulting from the directional coupler K, and the consequent reduction in level of the amplitude of signal from A, modulation of the MEGA-SWEEP while sweeping is very small.

The directional coupler K by virtue of its directivity attenuates to a great degree any energy transfer from A to B and thus isolates the two oscillators from each other, minimizing "pulling" when near the same frequency.

3.4 Wave Meter

An absorption type adjustable cavity wavemeter (G in Fig. 1) is coupled into wave guide H by means of a probe. At the resonant frequency of the cavity energy is absorbed from the wave guide and prevented from reaching detector F. This causes the meter M to indicate a current dip. The wavemeter is tuned by a plunger whose position is adjusted by a micrometer head. By successive readings on the two beat frequency oscillators a difference reading which is proportional to output frequency can be obtained.

3.5 Output System

The RF output system (refer to the schematic Fig. 2) consists of crystal D1 and its mounting, output connectors HIGH and LOW, R11, and R12. The indication of DC component in the output of crystal D1 is accomplished by the circuit including R14, R13, C5, C6, S1, R10, and M1.

The crystal D1 rectifies the energy from the wave guide in which it is placed; it is supported in a chuck whose position has been adjusted for best match between guide and crystal load. The chuck is separated from its housing by an insulating tape which forms the dielectric of a bypass capacitor for the microwave frequency components from the two beating oscillators. The HIGH output voltage is taken directly from D1. R12 and R11 form a voltage divider which presents at the LOW output connector a voltage approximately 20 to 1 lower than that at the HIGH connector. The impedance level at each of the connectors is approximately 50 ohms.

R13, C5, and C6 form a lowpass filter for passing the DC component of crystal current to meter M1. With switch S1 in the normal position (down on Fig. 2), the negative voltage from R8 and sweep voltage from R15 are connected to the repeller of V1, allowing it to operate. The sensitivity of M1 is kept low by the series resistor R10. Since the energy reaching D1 from V1 is much greater than that coming from V2, meter M1 essentially responds only to V1. When S1 is operated (up position in Fig. 2), V2 is rendered inoperative by grounding its repeller electrode; the meter sensitivity is increased by shorting out R10. In this position the meter responds only to the output of V2, as rectified by D1.

3.6 Sweep Circuit

Tube V4 (Fig. 2) is a 2D21 thyratron which with its associated elements comprises a relaxation oscillator, generating a sawtooth sweep voltage, a fraction of which is applied to tube V3, a 6C4 used as a cathode-follower. This tube has been added to present a low impedance (a few thousand ohms) at the SWEEP OUTPUT terminals J3, for the benefit of users of scopes having a low impedance at the horizontal input terminals. Any desired fraction of the output of V3 can be applied by means of R15, the SWEEP WIDTH control, to the repeller of V1, to produce the frequency sweep. The coupling network including C7 and R6 permits independent adjustment of the average repeller voltage as obtained from R8.

Control R22, the SWEEP RATE control, adjusts the frequency of sawtooth oscillator V4 between approximately 50 and 100 cps. A small portion of the 60 cps heater voltage is applied through R19 and R17 to the grid of V4 to cause locking to the line frequency over a small part of the range of control of R22.

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SECTION IV

INTERCONNECTIONS TO OTHER EQUIPMENT

4.1 Connection to Oscilloscope

A. Cable connections

The MEGA-SWEEP supplies through SWEEP OUT terminals a sawtooth voltage for deflecting the oscilloscope beam horizontally. The right terminal is connected to the high side terminal of the horizontal input of the oscilloscope. The oscilloscope should be set so that its internal sweep is not functioning.

B. Oscilloscope characteristics

The oscilloscope used should have a flat frequency response from 30 to at least 20,000 cps. The gain vertically should be approximately 0.5 volt per inch. For stage by stage measurements somewhat higher gain is desirable.

4.2 RF Connections to Test Circuits

Note: Before the RF output of the MEGA-SWEEP is used, a good connection should be established between the chassis under test and the MEGA-SWEEP. This precaution is partial protection against damaging the crystal. In any case it is good practice to provide ground connections between all units of a set-up.

RF connection of the output of the MEGA-SWEEP to a receiver is achieved by a length of RG 58/U cable which is included with the instrument. The shield of the cable should be grounded near the point at which the center conductor is connected. For use in the frequency range above 15 mc. a 100 mmf. mica or ceramic condenser should be used in series with the center conductor of the cable. This protects the crystal from damage in case the center conductor of the cable accidentally comes in contact with 6.3 heater voltage or other voltages which would burn out the crystal. In cases where an output voltage lower than maximum output is allowable the cable should be terminated by a 51 ohm Allen-Bradley resistor on the MEGA-SWEEP side of the condenser. The output end of the cable is then connected to the circuit under test.

4.3 Marker Connections

A. The MEGA-MARKER SR.

1) With the MEGA-SWEEP

This instrument can be used with the MEGA-SWEEP to produce a birdie marker on an oscilloscope display. The standard MEGA-MARKER SR. will give a birdie at the sound RF carrier point of each TV channel.

2) As an independent test instrument

The MEGA-MARKER SR., with its modulation "ON", may be used independently to align the local oscillator of any TV receiver by using the sound channel to monitor the modulating tone.

B. Signal generators:

Any signal generator may be used to produce a birdie display providing the correct levels are obtainable.

4.4 Connections to TV Receivers

A. MEGA-SWEEP to TV receiver:

For i.f. alignment a tube shield connected to the center conductor of the coaxial cable may be employed. This method utilizes the capacity of the shield can to the mixer plate to feed the i.f. amplifier.

In feeding RF signal into a balanced input type of receiver the standard coupling method of employing a coaxial-to-balanced resistor pad may be used.

B. Receiver output to oscilloscope:

1) Video detector

When feeding an oscilloscope from a detector a low pass filter such as has been described should be used.

2) Individual stage testing

When working stage by stage care should be taken that the input cable or the detector employed does not affect the circuit under test.

3) Special application for intercarrier TV receivers

In aligning this type of receiver, RF sound carrier signal from the MEGA-MARKER SR. is fed to the receiver antenna input terminals. Modulation on the MEGA-MARKER SR. is switched on and its selector switch is set to the channel required. The receiver should be set for the same channel. The MEGA-MARKER should be set to the i.f. picture carrier frequency and its signal loosely coupled to the mixer plate circuit. The fine tune control of the receiver should be centered and the local oscillator trimmed for the sound "dip" in between the two sound maxima which is characteristic of FM sound discriminators when detecting AM.

The above adjustment should be made only if the i.f. picture and sound channels have been properly aligned.

4.5 Pulse Modulation of the MEGA-SWEEP with the MEGA-PULSER

A. General:

The MEGA-PULSER provides output pulses 0.025, 0.05, 0.1 and 0.25 microseconds wide at repetition rates of 100, 1000 and 2000 pps. Positive or negative pulses of 100 volts amplitude are available at a 50 ohm level.

In testing the transient response of wide band RF amplifiers an RF carrier which can be keyed on and off by a train of pulses is required. The frequency of the RF carrier should be tunable so as to permit adjustment to a frequency within the pass band of the amplifier to be tested. A method of obtaining a pulse modulated carrier by use of the MEGA-SWEEP and MEGA-PULSER is described below.

B. Procedure:

1) Remove the cover of the klystron box. Remove the cap connector clip of klystron V2. Connect a 100,000 ohm resistor between this connector and the repeller cap of the klystron.

2) Connect a 10 db coaxial pad into the output of the MEGA-PULSER. Terminate the cable with two Allen-Bradley resistors in series which total approximately 51 ohms. 15 to 20 volts output should be obtained at the series point of the resistors.

3) Connect the output of the cable between the cap of klystron V2 and ground, using a 0.01 mf. blocking condenser. Caution should be taken to make lead lengths as short as possible.

C. Operation:

1) After the MEGA-SWEEP has been turned on and warmed up for five minutes, set the SWEEP AMPLITUDE to zero. Adjust the MEGA-SWEEP in the normal fashion.

2) Turn PEAKING ADJ. #2 so as to decrease the negative voltage on the repeller until the klystron just ceases to operate. This is done by depressing the PUSH switch and observing meter M1. Measure the resultant change in repeller voltage with a V.T.V.M. The pulse amplitude should be adjusted to approximate this value.

3) Energize the MEGA-PULSER with polarity switch set to give a negative pulse. Set the desired pulse width and repetition rate.

The output of the MEGA-SWEEP should now be a pulse modulated carrier at the frequency of the MEGA-SWEEP. The amplitude can be varied by the MEGA-SWEEP attenuator. Slight re-

adjustment of the FINE FREQUENCY ADJ. control may be necessary to obtain the RF frequency desired.

4.6 Use of External Sweep Voltages

High frequency external sweep voltages can be applied to the sweeping oscillator by use of the following connections:

A. Remove the shield cover of the klystrons; remove the repeller cap connection of klystron V1. Connect a 100,000 ohm resistor between the repeller cap and the connector that has been removed.

B. Connect the output of the sweep voltage source through a 0.01 mf. blocking condenser to the repeller. Approximately 20 volts peak to peak is needed.

C. Rotate the SWEEP AMPLITUDE control counterclockwise.

D. The same sweep voltage that is used for modulating the MEGA-SWEEP should be used to deflect the oscilloscope beam horizontally.

Low frequency sweeps can be externally supplied to the MEGA-SWEEP by removing the 6C4 tube, V3, from its socket and then applying the sweep voltage to the SWEEP OUT terminals. Again the same sweep source should be used for the oscilloscope. In this case the SWEEP AMPLITUDE potentiometer can be used to control the sweep amplitude. If extremely slow sweeps are used it may be necessary to direct-couple to the repeller.

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SECTION V

SERVICE AND MAINTENANCE NOTES

5.1 Low Output Signal

Decrease of RF output signal from the sweeping oscillator is in most cases accompanied by a decrease in DC current indication on the panel meter.

A. If low RF output is noted, the procedure outlined under Section II (Oscillator Peaking) should first be undertaken. If the panel meter indication is low or equal to zero, with peaking switch both in normal and in depressed position, a weak crystal is usually indicated. Remove crystal as indicated below, test as indicated below and replace, if defective, with type 1N23B. (Note: 1N21B will also operate.)

B. If panel meter indication is low or equal to zero with panel switch depressed, but normal with switch released, a defective #2 klystron is indicated.

C. If panel meter indication is low or equal to zero with panel switch released, but normal with switch depressed, a defective #1 klystron is indicated.

D. Reversing the klystrons to determine whether the current indications follow the tubes will indicate whether it is the tubes or the associated circuits which are at fault.

5.2 Voltage Measurement

Typical DC voltage values which appear at various circuit points in the sweeping oscillator are shown on Fig. 2. Two important voltages are + 300 and - 300 which are applied to the klystrons. These voltages may be measured by removing the shield box top at the right rear of the panel. A DC voltmeter (at least 20,000 ohms per volt) can then be used to measure the positive voltage between the klystron cavity nut and ground. This voltage should equal + 300. A screwdriver control on the power supply to the rear of the cabinet can be used to readjust this voltage. The negative 300 volt supply can be checked indirectly for proper operation by use of the same voltmeter between the tube cap of the klystron to the right, and ground. This voltage will read between approximately - 80 and - 240 volts, depending on the setting of PEAKING ADJ. #2. If the + 300 volts does not appear, the protective lamp (L2 in Fig. 2) attached to the terminal strip on the left rear of the panel should be removed from its socket and checked for continuity. If the lamp is continuous it should be reinserted in its socket and the tubes in the power supply checked. If the lamp is not a continuous circuit each klystron should be removed from its socket and a continuity check made between shell and the cathode pin. A short indicates a defective tube. Replace klystron and protective lamp. If no short is found in the klystrons, the by-pass condenser (C3 in Fig. 2) should be checked.

5.3 Crystal Removal

The crystal detector, D1 in Fig. 2, is inserted in a chuck in the wave guide behind the left rear of the panel just back of the output connectors HIGH and LOW. To remove the crystal, loosen the thumb screw and lift the crystal by grasping the crystal flange with a pair of cross cutters and lifting. To replace, drop the crystal gently into the chuck with tip connection down. Rock crystal from side to side while pressing down gently. When firmly seated all the way in, tighten the screw by hand.

5.4 Crystal Testing

To determine whether the crystal D1 in Fig. 2 is defective, check the resistance between the connecting tip and flange with a standard ohmmeter set on the RX 100 scale. Note resistance. Reverse polarity of leads from the ohmmeter at the crystal and note this resistance. One of the two resistance readings should be approximately 200 ohms and the other above 5000 ohms. The high resistance figure on a bad crystal will be low and, in the case of a completely defective crystal, approximately equal to the low resistance value; or sometimes both resistances will be high.

5.5 Crystal Protection - IMPORTANT

A. The chassis under test and other equipment used should be bonded to the chassis of the MEGA-SWEEP before the RF output cable is used. This bond should be maintained throughout the test. Do not depend on the shield of the RF cable for this connection. Test chasses are frequently above ground potential and currents can be passed through the detector if the hot side of the RF cable touches the chassis before a ground is made.

B. For MEGA-SWEEP applications in a frequency range above 15 mc. a 100 mmf. condenser should be used in series with the "hot side" of the RF cable at the test circuit. Tape the exposed portions of the connection between the cable and the series condenser.

C. Avoid connection of the RF cable to any point on which a DC potential exists.

D. Do not use auxiliary marker equipment in parallel with the MEGA-SWEEP output if the marker output levels are greater than 2.0 volts.

Careful attention to the details itemized above will reduce crystal detector failures to a great degree.

5.6 Klystron Replacement

The two klystrons (V1 and V2 in Fig. 2) are located in a shield box attached to the right rear of the panel. To replace klystrons remove the two screws at the

top of the shield box and remove the top. Note that the metal shells of the klystrons are at + 300 volts and the power switch should be turned off before contact is made with the tubes. The fixed frequency (#2) klystron is located to the right when viewed from the front of panel. The variable frequency or swept klystron (#1) is located to the left when viewed from the front panel. To replace the #2 klystron remove the top cap connection and carefully withdraw tube from socket. Insert new tube, taking care to insert probe into the large hole in socket. The tube should be rocked as it is lowered so that the probe engages the wave guide beneath. A similar procedure is followed in replacing klystron #1, except that the COARSE FREQ. ADJ. knob and shaft assembly must be moved away from the panel about 1/2 inch, disengaging the cavity tuning nut on klystron #1. When the tube is replaced the COARSE FREQ. ADJ. assembly must be pushed in to re-engage the cavity tuning nut.

After klystron #2 is replaced, carry out the procedure outlined in Section II (Oscillator Peaking). The cavity nut must then be adjusted to obtain a dip on the meter with the PUSH switch on the panel depressed and the wavemeter set between 1850 and 1950. An insulated wrench must be used on this nut or the power turned off before contact is made with it.

The klystrons are fused with a protective lamp (L2 in Fig. 2) which is located on the terminal strip to the left rear of the panel. When a shorted klystron is replaced, it is necessary to replace this lamp.

5.7 Fuse Replacement

The AC power to the MEGA-SWEEP is fused by a 3 ampere fuse screwed into a fuse holder from the front panel (F1 on Fig. 2).

SECTION VI

METHODS OF SETTING FREQUENCY

6.1 By Use of Test Circuit

A method of measuring and adjusting the center frequency of the sweeping oscillator using the FREQUENCY METER was described in Section II. In using the unit with a television receiver or in other cases where the frequency of the pass band is known, the use of the wavemeter can sometimes be omitted. The sweeping oscillator is connected to the test circuit and the oscilloscope. The display can then be obtained by simply tuning the COARSE FREQUENCY ADJ. until a response appears on the oscilloscope. The COARSE FREQUENCY ADJ. should be rotated clockwise for higher frequency and counterclockwise for lower frequency. If the frequency is varied over a wide range, it will be necessary to repeak PEAKING ADJ. #1 if the reading on the panel meter decreases appreciably.

In using the method outlined in the above paragraph on a television receiver, it is possible to get two responses. One of these occurs when the sweeping oscillator is sweeping through the i.f. frequencies; the other when it sweeps the RF frequencies. The i.f. sweep can be identified by switching the receiver channel switch. If the oscilloscope display moves horizontally, an RF sweep is being injected; if there is no shifting of the display, the sweep input is i.f.

6.2 Use of Wavemeter with Oscilloscope Display

A. Measurement of absolute frequency:

When the sweeping oscillator is in use with a test circuit and oscilloscope, the FREQUENCY METER can be used to identify frequencies within the pass band. The accuracy of this measurement is approximately one megacycle. To make this measurement the following procedure should be used:

1) Rotate the FREQUENCY METER until the entire pattern on the oscilloscope decreases to a minimum in amplitude. Note the reading on the FREQUENCY METER scale.

2) Rotate the FREQUENCY METER until the minimum of the visual absorption dip which appears on the oscilloscope coincides with the point at which frequency is to be read. Note the reading on the FREQUENCY METER scale and obtain the difference between this reading and the one obtained in 1) above.

3) Apply the proper multiplying factor from Table I to obtain the frequency in megacycles of the point on the sweep at which the absorption dip was positioned.

B. Measurement of frequency differences:

The FREQUENCY METER can be used to measure frequency difference along the oscilloscope display on broad band displays. The dip which appears on the display as the FREQUENCY METER is varied can be set at two successive points on the display between which the frequency difference is desired. The difference between the micrometer readings obtained from FREQUENCY METER settings can then be multiplied by the factors in Table II to obtain the frequency difference in megacycles.

C. Calibration correction for the FREQUENCY METER:

In using FREQUENCY METER (G in Fig. 1) a factor must be used to multiply the difference between the two micrometer scale readings. For rough measurements a factor of 0.5 may be used. For more accurate determination, factors as indicated in Table I below should be used.

Table I (Absolute Frequency)

FREQUENCY METER Reading Difference (#2 klystron - #1 klystron)	Multiply Difference by
0 to 100	0.50
100 to 400	0.49
400 to 725	0.48
725 to 1250	0.47
1250 to 1600	0.46
1600 to 1800	0.45

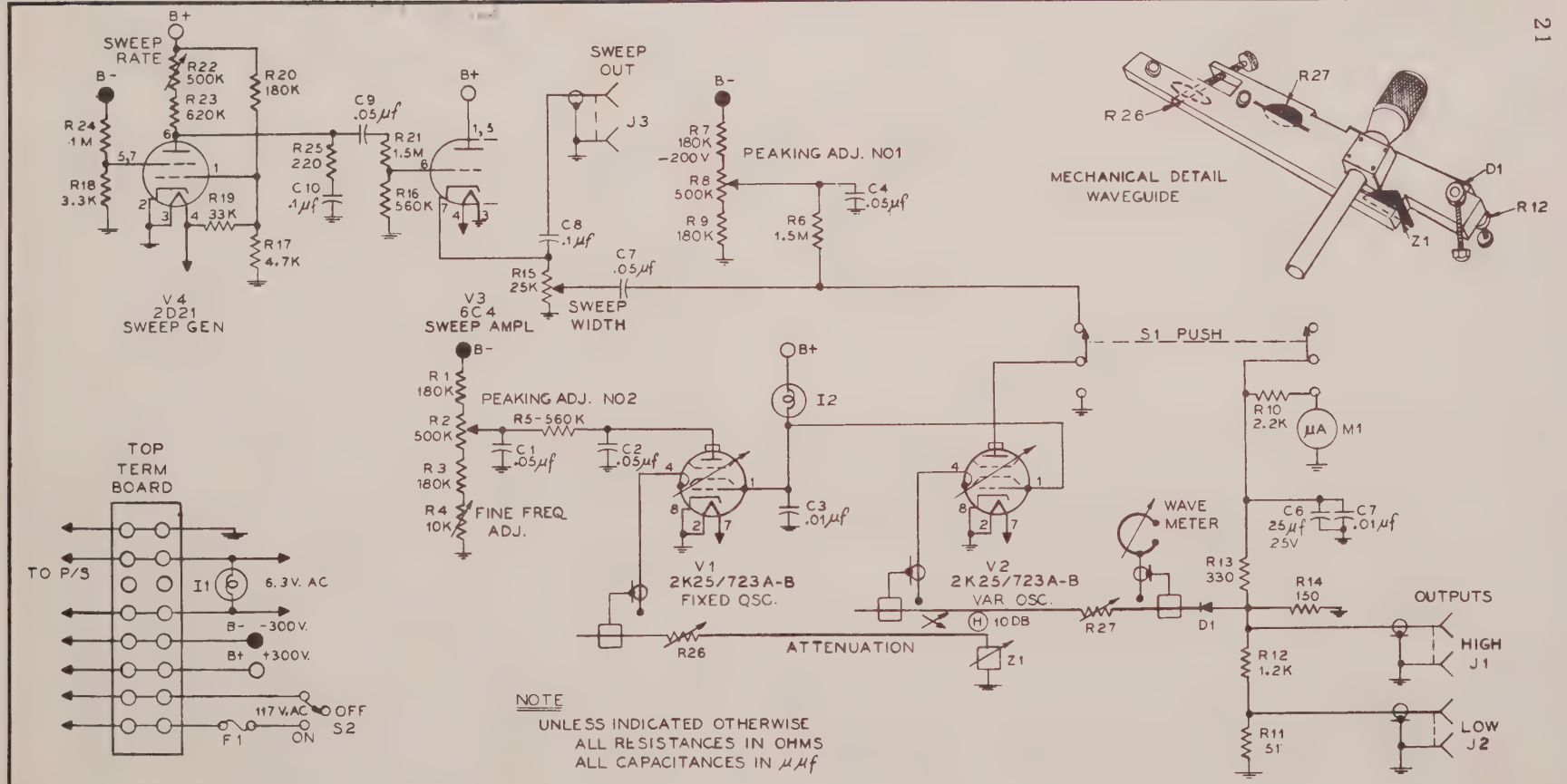
For determining the frequency difference along the sweep, the following correction factors should be used:

Table II

Micrometer Scale Readings Between	Multiply Difference by
1900 and 1800	0.50
1800 and 1600	0.49
1600 and 1400	0.48
1400 and 1200	0.47
1200 and 1000	0.46
1000 and 750	0.45
750 and 500	0.44
500 and 300	0.43
300 and 0	0.42

PARTS LIST (KB-1223-F)

DWG. SYMBOL NO.	DESCRIPTION	KAY PART NO.
	Capacitors:	
C-1	0.05μF, 600 VOLTS, PAPER	6353-3
C-2	0.05μF, 600 VOLTS, PAPER	6353-3
C-3	0.01μF, 500 VOLTS, CERAMIC DISC	6360-6
C-4	0.05μF, 600 VOLTS, PAPER	6353-3
C-5	0.01μF, 500 VOLTS, SILVER MICA	6359-41
C-6	25μF, 25 VOLTS, ELECTROLYTIC	6355-4
C-7	0.05μF, 600 VOLTS, PAPER	6353-3
C-8	0.1μF, 400 VOLTS, PAPER	6353-4
C-9	0.05μF, 600 VOLTS, PAPER	6353-3
C-10	0.1μF, 400 VOLTS, PAPER	6353-4
D-1	1N21B CRYSTAL DIODE	6357-16
F-1	FUSE, 3 AMP, 250 VOLTS	245
I-1	LIGHT INDICATOR #44	249
I-2	LIGHT INDICATOR #44	249
J-1	JACK, UG-185/U	204
J-2	JACK, UG-185/U	204
J-3	BINDING POST, 938 A&Z	257
M-1	METER, 0-200 DC UA	324
	Resistors: (UNLESS OTHERWISE SPECIFIED, ALL COMPONENTS ARE FIXED COMPOSITION, ½ WATT, 10% TOLERANCE RESISTORS.)	
R-1	180 K	1841-E
R-2	500 K, 2 WATT POT, VARIABLE	126
R-3	180 K	1841-E
R-4	25 K, 2 WATT, POT, VARIABLE	113
R-5	560 K	5641-E
R-6	1.5 M	1551-E
R-7	180 K	1841-E
R-8	500 K, 2 WATT, POT, VARIABLE	126
R-9	180 K	1841-E
R-10	2.2 K	2221-E
R-11	51, 5% TOLERANCE	5105-E
R-12	1.2 K	1221-E
R-13	330	3311-E
R-14	150	1511-E
R-15	500 K, 2 WATT, POT, VARIABLE	126
R-16	560 K	5641-E
R-17	4.7 K	4721-E
R-18	3.3 K	3321-E
R-19	33 K	3331-E
R-20	180 K	1841-E
R-21	1.5 M	1551-E
R-22	500 K, 2 WATT, POT, VARIABLE	126
R-23	330 K	3341-E
R-24	1 M	1051-E
R-25	220	2211-E
R-26	CARBON RESISTANCE CARD	59
R-27	CARBON RESISTANCE CARD	58
R-28	220 K	2241-E
S-1	SWITCH, TOGGLE DPDT	256-C
S-2	SWITCH, TOGGLE, SPST	255-C
V-1	TUBE, 2K25/723 A-B	2K25/723 A-B
V-2	TUBE, 2K25/723 A-B	2K25/723 A-B
V-3	TUBE, 6C4	6C4
V-4	TUBE, 2D21	2D21
Z-1	CARBON RESISTANCE CARD	52



NOTE

UNLESS INDICATED OTHERWISE
ALL RESISTANCES IN OHMS
ALL CAPACITANCES IN μμf

SCHEMATIC STANDARD MEGA - SWEEP

MAT.	FINISH:	SCALE:

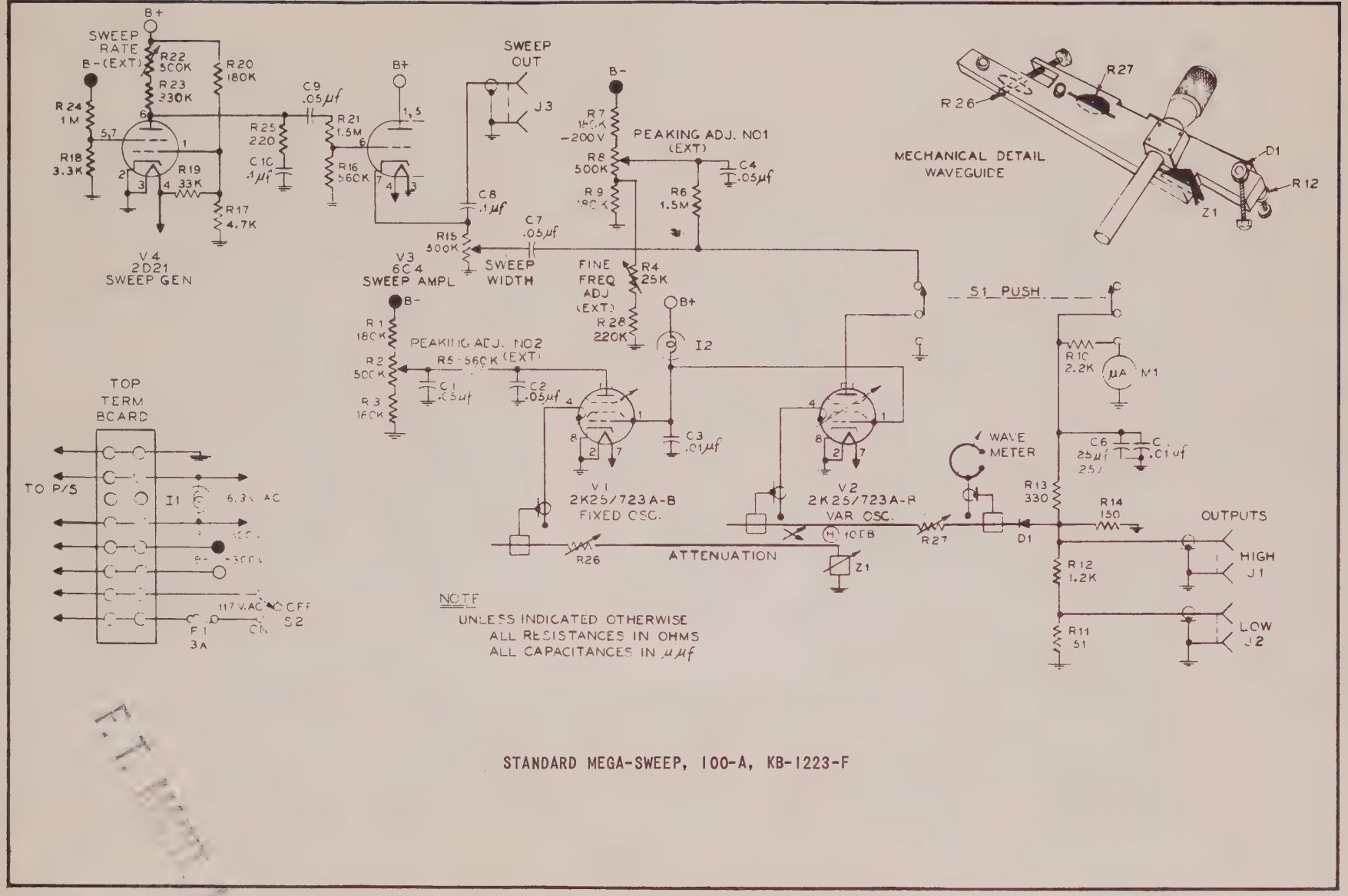
DIMENSIONS TOLERANCES UNLESS OTHERWISE SPECIFIED:
DECIMAL DIMENSIONS ± .002 FRACTIONAL DIMENSIONS ± .006

CHANGE	DATE	APP.
"D" R7 was 430K, R9 was 220K	4/13	CH

KAY ELECTRIC CO.
PINE BROOK, N. J.

DWN. BY AWPIERCE DATE 4-13-56
APP. BY C.H. DATE 4-16-56

DWG. NO. KB 1223 D



NOTE

UNLESS INDICATED OTHERWISE
ALL RESISTANCES IN OHMS
ALL CAPACITANCES IN μμf

STANDARD MEGA-SWEEP, 100-A, KB-1223-F

APPENDIX A

THE CALIBRATED MEGA-SWEEP

1. Description

The calibrated Mega-Sweep is a revised model of the standard Mega-Sweep. A drive mechanism has been attached to provide for automatic tracking of the klystron COARSE FREQUENCY ADJ. control with the #1 PEAKING control. At the same time, an approximate indication of output frequency is provided on a direct-reading, frequency-calibrated dial which is part of the attached mechanism.

2. Operation

The operating procedure for the standard Mega-Sweep described in the foregoing pages applies to the Calibrated Mega-Sweep with the following exceptions:

a. Manual operation of the #1 PEAKING control has been eliminated.

b. Adjustment of the COARSE FREQUENCY ADJ. control to a particular frequency setting should always be made in a clockwise direction to eliminate back-lash effects in the mechanism.

As usual, maximum sweep amplitude should be used in obtaining the initial display of a response curve. Centering of the displayed response pattern may be achieved by slight adjustment of the COARSE FREQUENCY ADJ. control and by adjustment of the FINE FREQUENCY ADJ. control.

3. Replacement of Klystrons

Replacement klystrons for the Calibrated Mega-Sweep must be obtained directly from the factory. PURCHASE ORDERS SHOULD SPECIFY THE SERIAL NUMBER OF THE PARTICULAR INSTRUMENT INVOLVED AND SHOULD INDICATE THE INTENDED USE OF THE TUBE IN EITHER THE #1 (VARIABLE FREQUENCY OSCILLATOR) POSITION OR THE #2 (FIXED FREQUENCY OSCILLATOR) POSITION. ORDERS SHOULD BE ADDRESSED TO THE ATTENTION OF THE TEST DEPARTMENT.

All replacement tubes shipped from the factory will bear identifying data as to intended position (#1 or #2) and frequency setting. Those tubes designated for the #2 position will have marked upon them the approximate wavemeter frequency indication to which these tubes should be tuned. Those tubes designated for the #1 position will have marked upon them the frequency indication to which the accompanying #2 klystron should be tuned.

4. Resetting of Klystrons

(Read Sec. 5.6, page 18 before attempting the following operations). In order to re-establish the necessary operating condition of the instrument after replacement of klystrons, the following procedure should be followed:

a. Tune the #2 klystron for a wavemeter dip at the frequency indication marked on the replacement tube.

b. Tune the #1 klystron to the same frequency to which klystron #2 has been set; i.e., zero resultant output (beat) frequency.

c. With the FINE FREQUENCY ADJ. set in the middle of its range, adjust the internal screw-driver potentiometer (located behind the panel adjacent to the micro-ammeter) for maximum "#1 Peaking".

d. With the instrument power turned off, dis-engage the COARSE FREQUENCY ADJ. shaft from the cavity nut of the #1 klystron and rotate it to its counter-clockwise limit.

e. Back off slightly from this limit (a small fraction of a turn) and re-engage the cavity nut.

f. Re-tune the #1 klystron for zero beat.

g. Re-adjust the internal potentiometer for maximum current.

h. Loosen the hex nut which holds the calibrated dial, and rotate the dial until its zero reading is opposite the indicating pointer (this should be done without disturbing the setting of the COARSE FREQUENCY ADJ. control).

i. Re-tighten the hex nut to lock the calibrated dial in position.

The frequency calibration of the dial may now be checked by comparison with the FREQUENCY METER.

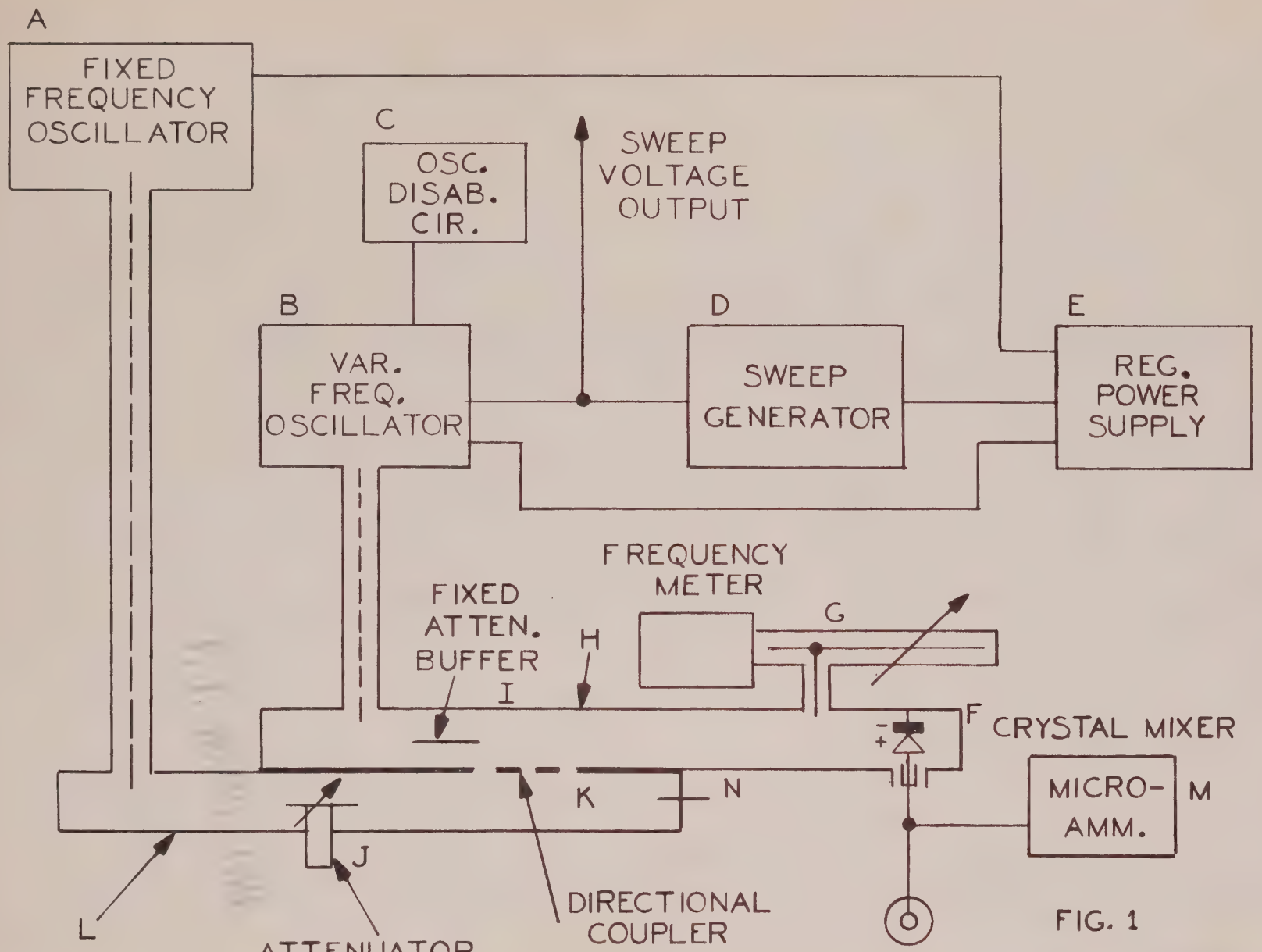
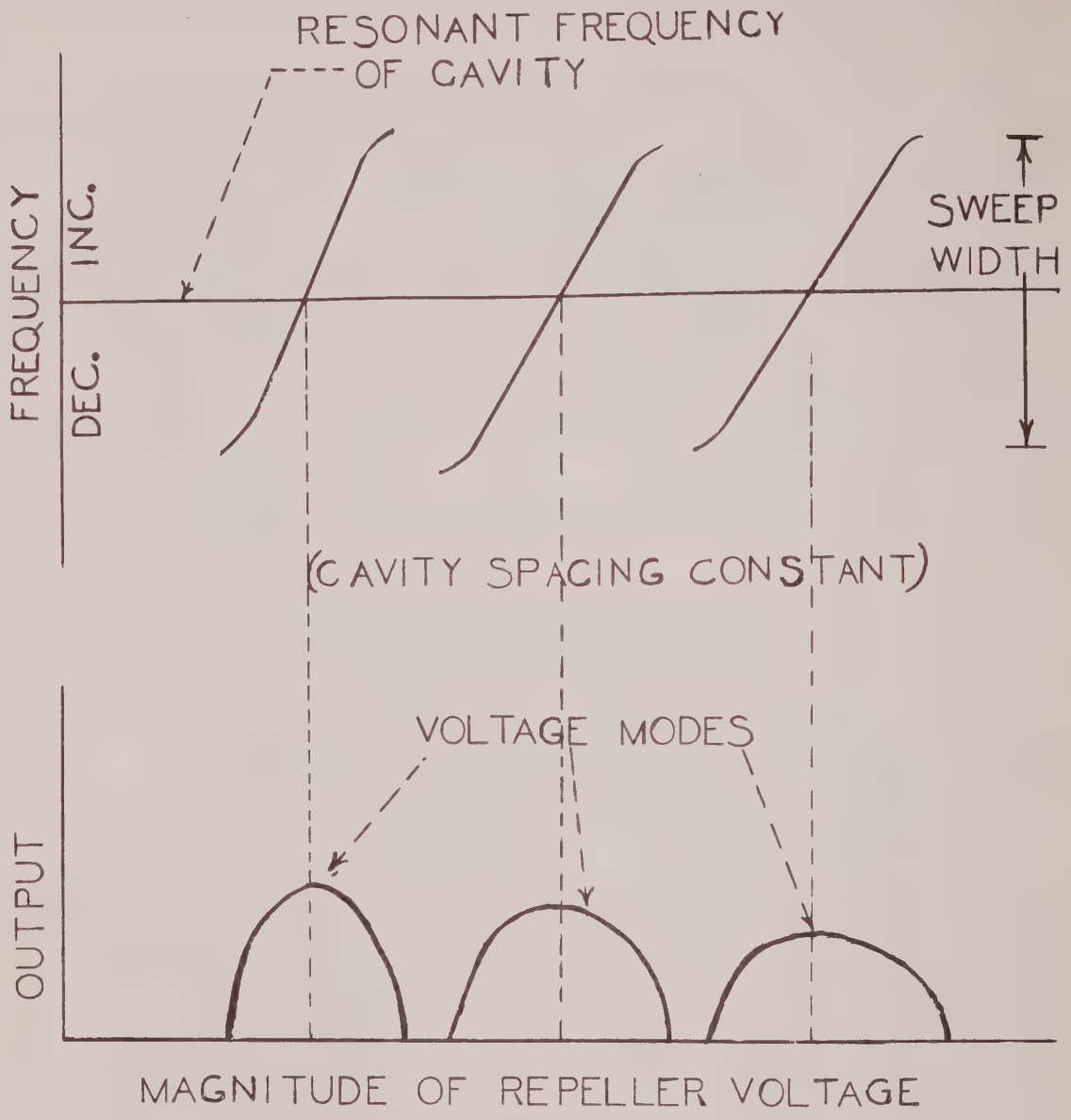


FIG. 1
BLOCK DIAGRAM



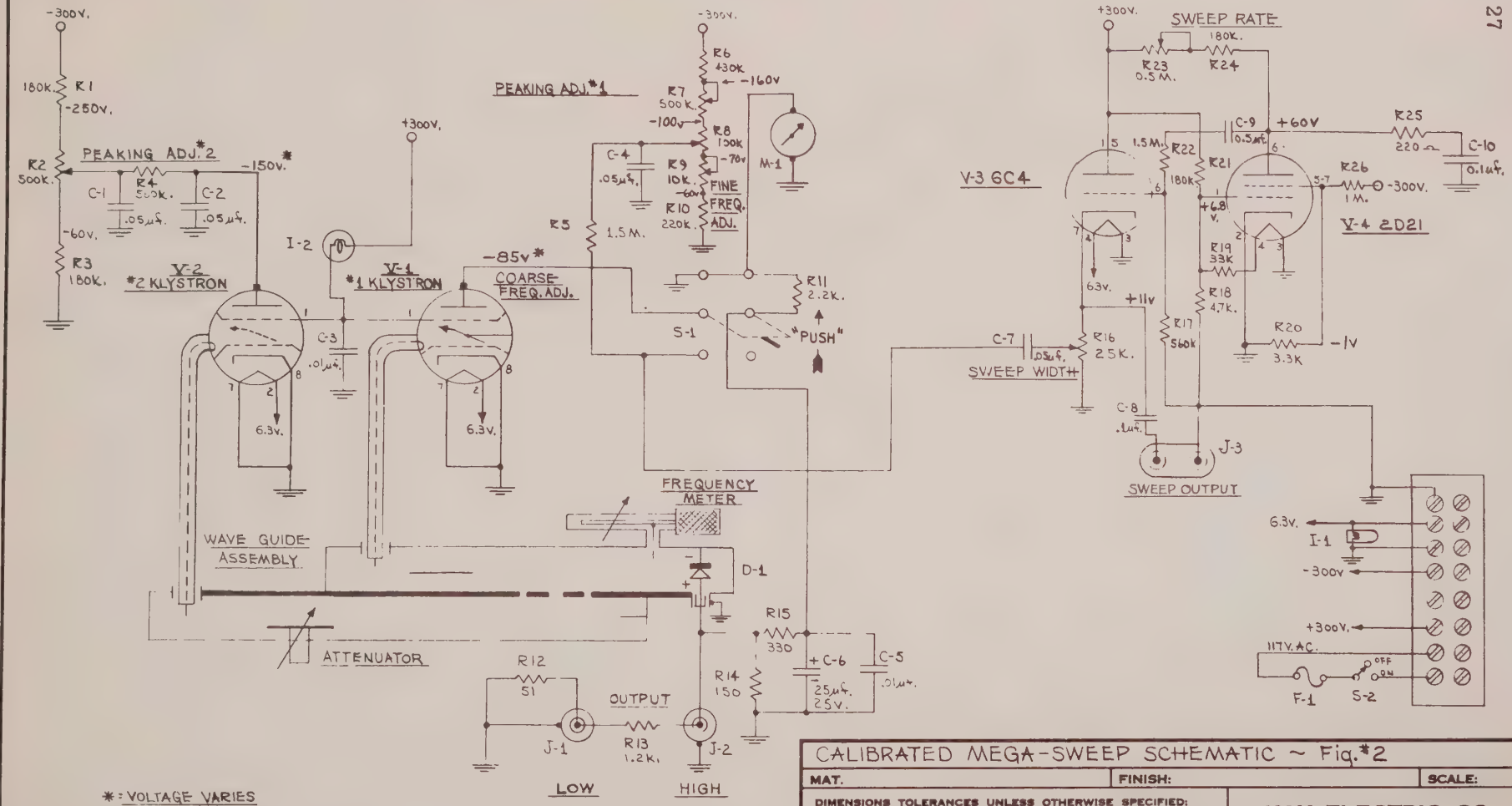
KLYSTRON CHARACTERISTICS

FIG. 3

PARTS LIST (KB-1615-D)

DWG. SYMBOL NO.	DESCRIPTION	KAY PART NO.
	Capacitors:	
C-1	0.05μF, 400V, MYLAR-PAPER	6899-6
C-2	0.05μF, 400V, MYLAR-PAPER	6899-6
C-3	0.01μF, 500V, CERAMIC DISC	6360-6
C-4	0.05μF, 400V, MYLAR-PAPER	6899-6
C-5	0.01μF, 500V, CERAMIC DISC	6360-6
C-6	25μF, 25V, ELECTROLYTIC	6355-4
C-7	0.05μF, 400V, MYLAR-PAPER	6899-6
C-8	0.1μF, 400V, MYLAR-PAPER	6899-2
C-9	0.05μF, 400V, MYLAR-PAPER	6899-6
C-10	0.1μF, 400V, MYLAR-PAPER	6899-2
D-1	1N23B, CRYSTAL DIODE	6357-26
F-1	FUSE, 3 AMP, 250V	245
I-1	LIGHT INDICATOR, BAYONET #44	249
I-2	LIGHT INDICATOR, BAYONET #44	249
J-1	CONNECTOR, UG-185/U	204
J-2	CONNECTOR UG-185/U	204
J-3	BINDING POST	257
M-1	METER, 0-200 DC MA	324
	Resistors: (UNLESS OTHERWISE INDICATED, ALL COMPONENTS ARE FIXED COMPOSITION, ½ WATT, 10% TOLERANCE RESISTORS.)	
R-1	180 K	1841-E
R-2	500 K, 2 WATT POT, VARIABLE	126
R-3	180 K	1841-E
R-4	560 K	5641-E
R-5	1.5 M	1551-E
R-6	430 K, 5% TOLERANCE	4345-E
R-7	500 K, 2 WATT POT, VARIABLE	126
R-8	100 K, 2 WATT POT, VARIABLE	121
R-9	25 K, 2 WATT POT, VARIABLE	113
R-10	220 K,	2241-E
R-11	2.2 K	2221-E
R-12	51, 5% TOLERANCE	5105-E
R-13	1.2 K	1221-E
R-14	150	1511-E
R-15	330	3311-E
R-16	25 K, 2 WATT POT, VARIABLE	113
R-17	560 K	5641-E
R-18	4.7 K	4721-E
R-19	33 K	3331-E
R-20	3.3 K	3321-E
R-21	180 K	1841-E
R-22	1.5 M	1551-E
R-23	500 K, 2 WATT POT, VARIABLE	126
R-24	330 K	3341-E
R-25	220	2211-E
R-26	1 M	1051-E
S-1	SWITCH, TOGGLE, DPDT	256-C
S-2	SWITCH, TOGGLE, SPST	255-C
V-1	TUBE, 2K25/723AB (KLYSTRON)	2K25/723AB
V-2	TUBE, 2K25/723AB (KLYSTRON)	2K25/723AB
V-3	TUBE, 6C4	6C4
V-4	TUBE, 2D21	2D21

F. T. MAINT. LAB



NOTE:-

ALL RESISTOR VALUES ARE IN OHMS, K=1000, M=1,000,000 ½WATT SIZE.
" CAPACITOR " " " MICROFARADS.

CALIBRATED MEGA-SWEEP SCHEMATIC ~ Fig.*2

MAT.	FINISH:	SCALE:

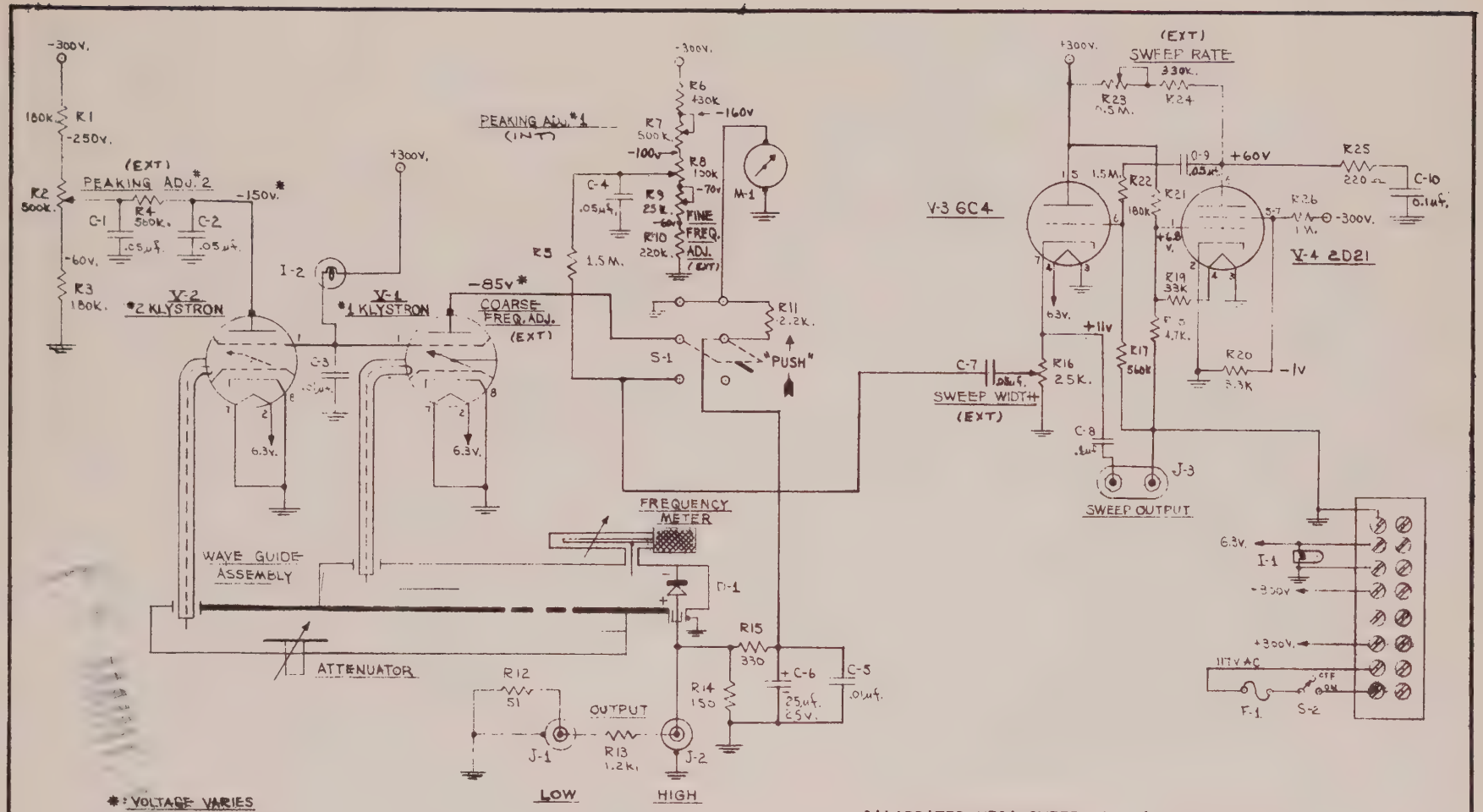
DIMENSIONS TOLERANCES UNLESS OTHERWISE SPECIFIED:
DECIMAL DIMENSIONS ± .002 FRACTIONAL DIMENSIONS ± .006

CHANGE	DATE	APP.
REVISION "A" - MEGA-"X" SWEEP CKTS. WITH 6C4 TUBE NOW USED IN PLACE OF MEGA-SWEEP 2D21 CKTS. - PER J.S. & J.L.K.	7/24/53	

KAY ELECTRIC CO.
PINE BROOK, N. J.

DWN. BY J.L.K.	DATE 7-21-53
APP. BY	DATE 7-24-53

DWG. NO.-KB-1615-A



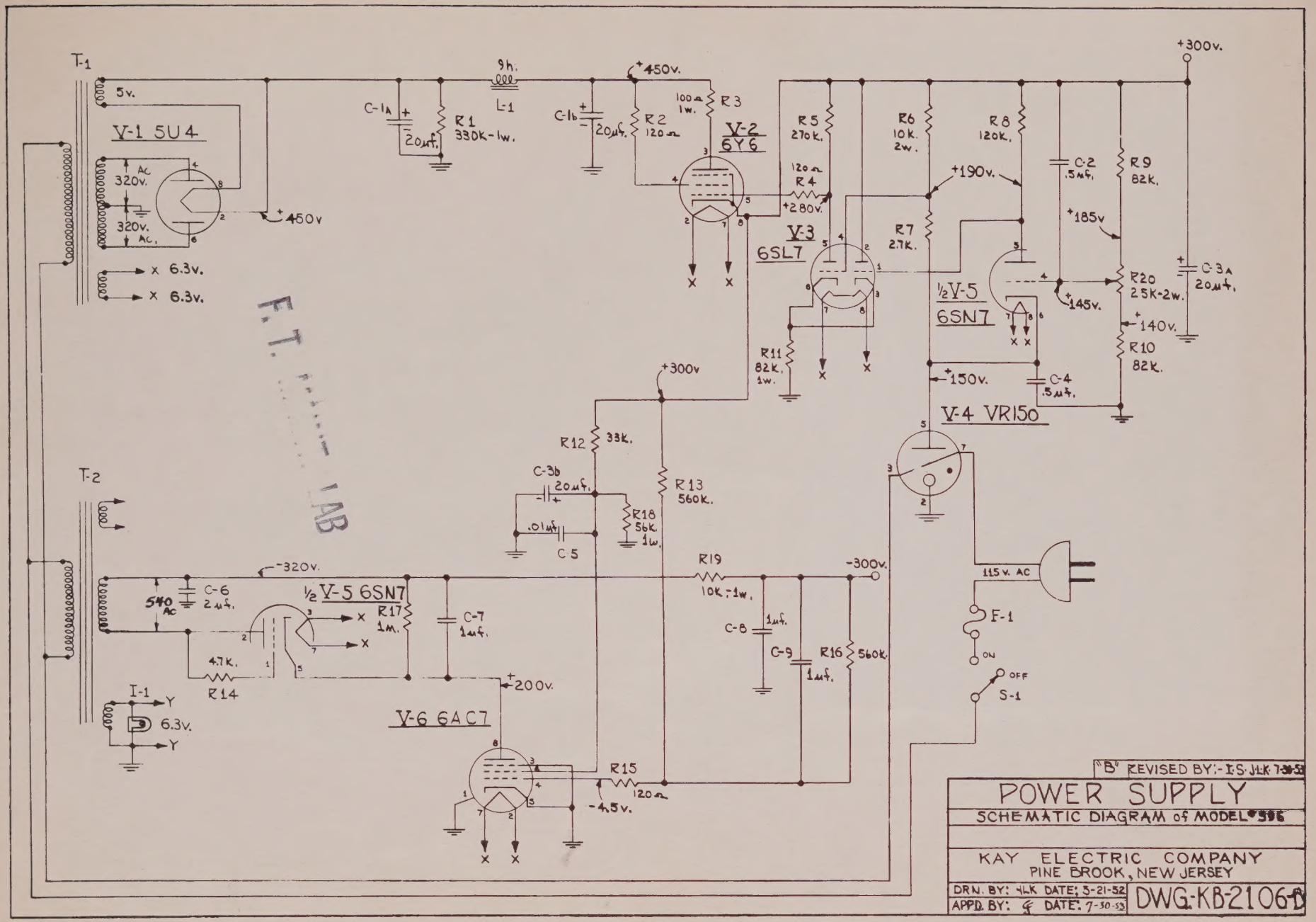
CALIBRATED MEGA-SWEEP, 110-A, KB-1615-D

NOTE:-
ALL RESISTOR VALUES ARE IN OHMS, K=1000, M=1,000,000 ½ WATT SIZE.
" CAPACITOR " " " MICROFARADS.

396 POWER SUPPLY (KB-2106-F)

PARTS LIST

DWG. SYMBOL NO.	DESCRIPTION	KAY PART NO.
	Capacitors:	
C-1 A&B	20/20 μF, 500V, ELECTROLYTIC	6355-11
C-2	0.5 μF, 600V, BATHTUB	325
C-3 A&B	20/20 μF, 450V, ELECTROLYTIC	331
C-4	0.5 μF, 600V, BATHTUB	325
C-5	0.01 μF, 500V, CERAMIC DISC	6360-6
C-6 A&B	1/1 μF, 600V, BATHTUB	1748
C-7	1 μF, 600V, BATHTUB	326
C-8 A&B	1/1 μF, 600V, BATHTUB	1748
L-1	CHOKE, 10 HY	323B
P-1	AC LINE CORD	328
	Resistors:	
R-1	330 K, 1 WATT, 10% TOLERANCE	3341-G
R-2	120, ½ WATT, 10% TOLERANCE	1211-E
R-3	100, 1 WATT, 10% TOLERANCE	1011-G
R-4	120, ½ WATT, 10% TOLERANCE	1211-E
R-5	270 K, ½ WATT, 10% TOLERANCE	2741-E
R-6	10 K, 2 WATT, 10% TOLERANCE	1031-H
R-7	2.7 K, ½ WATT, 10% TOLERANCE	2721-E
R-8	120 K, ½ WATT, 10% TOLERANCE	1241-E
R-9	82 K, ½ WATT, 10% TOLERANCE	8231-E
R-10	82 K, ½ WATT, 10% TOLERANCE	8231-E
R-11	82 K, 1 WATT, 10% TOLERANCE	8231-G
R-12	33 K, 1 WATT, 10% TOLERANCE	3331-G
R-13	560 K, ½ WATT, 10% TOLERANCE	5641-E
R-14	4.7 K, ½ WATT, 10% TOLERANCE	4721-E
R-15	120, ½ WATT, 10% TOLERANCE	1211-E
R-16	560 K, ½ WATT, 10% TOLERANCE	5641-E
R-17	1 M, ½ WATT, 10% TOLERANCE	1051-E
R-18	56 K, 1 WATT, 10% TOLERANCE	5631-G
R-19	10 K, 1 WATT, 10% TOLERANCE	1031-G
R-20	25 K, 2 WATT POT, VARIABLE	114
R-21	FACTORY SELECTED	
T-1	TRANSFORMER, POWER	321
T-2	TRANSFORMER, POWER	319
V-1	TUBE, 5U4	5U4
V-2	TUBE, 6Y6	6Y6
V-3	TUBE, 6SL7	6SL7
V-4	TUBE, OD3/VR-150	OD3/VR150
V-5	TUBE, 6SN7	6SN7
V-6	TUBE, 6AC7	6AC7



"B" REVISED BY:- I.S. J.L.K. 7-30-53

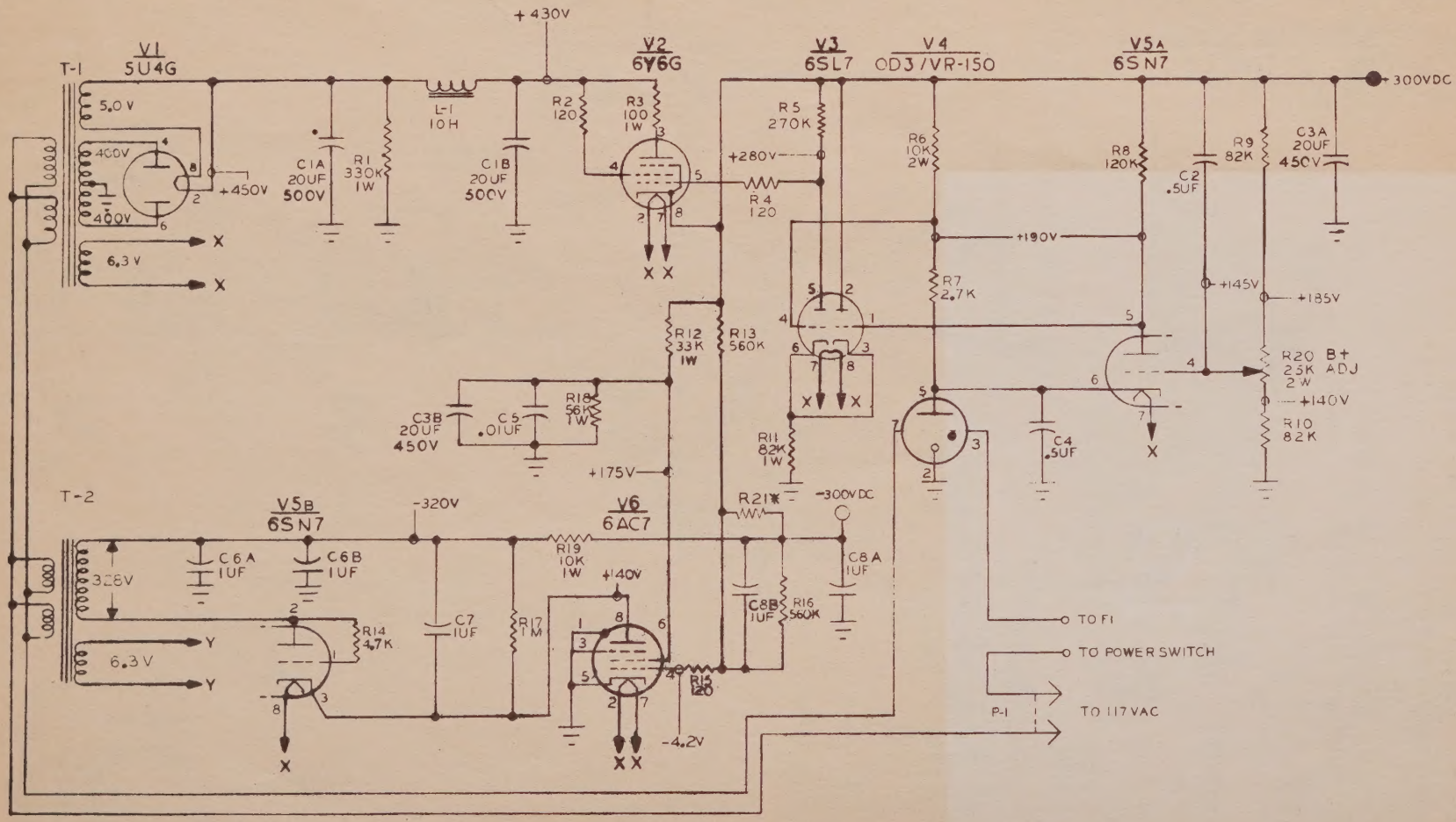
POWER SUPPLY

SCHEMATIC DIAGRAM of MODEL 596

KAY ELECTRIC COMPANY
PINE BROOK, NEW JERSEY

DRN. BY: J.L.K. DATE: 5-21-52
APPD. BY: [illegible] DATE: 7-30-53

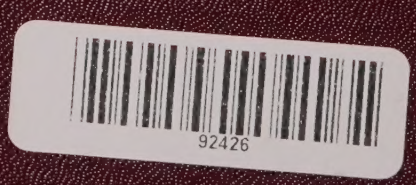
DWG. KB-2106-B



SELECTED — MAY BE OMITTED

MODEL 396 POWER SUPPLY, KB-2106-F

F. T. MAINT. LAB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